



UNIVERSITI PUTRA MALAYSIA

**LINEAMENT MAPPING IN MALAYSIAN TROPICAL FOREST
ENVIRONMENT UTILIZING LANDSAT IMAGERY**

NORHAKIM BIN YUSOF

FPAS 2009 2

**LINEAMENT MAPPING IN MALAYSIAN TROPICAL FOREST
ENVIRONMENT UTILIZING LANDSAT IMAGERY**

By

NORHAKIM BIN YUSOF

GS 18948

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfillment of Requirement for the Degree of Master of Science,
Faculty of Environmental Studies
Universiti Putra Malaysia**

March 2009



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science.

**LINEAMENT MAPPING IN MALAYSIAN TROPICAL FOREST
ENVIRONMENT UTILIZING LANDSAT IMAGERY**

By

Norhakim Bin Yusof

March 2009

Chairman : Associate Professor Dr Mohammad Firuz bin Ramli, PhD

Faculty : Faculty of Environmental Studies

The remote sensing application of multispectral data analysis has been proven as a useful tool in geological exploration especially in lineament identification and mapping. This study demonstrates the use of multispectral Landsat TM and ETM+ satellite data obtained in different two acquisition dates in year 1990 and 2002 for lineament interpretation in a Malaysian tropical forest environment. The Digital Elevation Model (DEM) was also been utilized to improve the interpretation process. Utilizing the rose diagram analysis and histogram superimposition, it was found that most of the major orientations from field station were successfully matched with the orientations from extracted lineaments obtained from the imageries. The lineaments also found to be structurally controlled by the river segments. Thus river segments may be used as a basis in the early stage of interpretation where the knowledge of general lineament trend is necessary. The results from the study showed that remote

sensing technique through the manual extraction is capable of extracting lineament trends in tropical forest which inaccessible by conventional survey technique. The undertaken steps may be utilized as an ideal framework of lineaments extraction utilizing the Landsat imagery in tropical forest environment such as Malaysia.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk Ijazah Master Sains.

**LINEAMENT MAPPING IN MALAYSIAN TROPICAL FOREST
ENVIRONMENT UTILIZING LANDSAT IMAGERY**

Oleh

Norhakim Bin Yusof

Mac 2009

Pengerusi : Profesor Madya Dr Mohammad Firuz bin Ramli, PhD

Fakulti : Fakulti Pengajian Alam Sekitar

Aplikasi sistem penderian jauh bagi analisis data multispectral telah terbukti berguna didalam eksplorasi geological terutamanya didalam pengenalpastian dan pemetaan lineament. Di dalam kajian ini telah menunjukkan kegunaan imej multispectral satelit iaitu Landsat TM dan ETM+ yang diperolehi pada tarikh yang berbeza meliputi tahun 1990 dan 2002 bagi tujuan interpretasi lineament bagi persekitaran tropika Malaysia. Digital Elevation Model (DEM) juga digunakan untuk meningkatkan lagi kualiti interpretasi. Dengan menggunakan analisis rose diagram dan histogram superimposition, didapati bahawa sebahagian besar orientasi utama yang diperolehi dari station kajian boleh didapati pada orientasi lineament yang diperolehi daripada imej satelit. Lineament juga didapati dipengaruhi dengan struktur segmen sungai. Dengan itu, segmen sungai boleh digunakan sebagai rujukan pada peringkat awal

interpretasi dimana ia memberi gambaran awal lineament amat diperlukan. Hasil kajian ini menunjukkan bahawa teknik penderian jauh secara manual boleh mengekstrak lineament daripada hutan tropika yang sukar dilakukan dengan menggunakan teknik pengukuran conventional. Langkah-langkah yang telah dijalankan didalam kajian ini boleh dijadikan sebagai rangkakerja yang sesuai bagi mengakstrak lineament dengan menggunakan imej Landsat bagi kawasan hutan tropika seperti Malaysia.

ACKNOWLEDGEMENTS

Praise to **ALLAH** the Almighty God that has given me opportunity, strength, and courage to complete this master thesis.

Due to that, I would like to express my gratitude to my energetic and dedicated supervisor, Dr Mohammad Firuz bin Ramli and Dr Helmi Zulhaidi bin Mohd Shafri who is also one of the committee member for the master research project for their wise advice, strong effort, and guidance through steps by steps showing the path to achieve the objective of this study. This appreciation also goes to all the lecturers in Faculty of Environmental Studies, Faculty of Engineering and for supporting staff who contribute in completing this project research.

I also would like to express my truly thanks to my own beloved mother, Badariah binti Jalani, to my supportive father, Yusof bin Mohd Nor, to my sisters, Yusdita and Yudilia, and also to my dearest, Nur Ilyana binti Mohd Zukki for giving me continuous love and strengthen my spirits.

Also not to forget, this appreciation also goes to all my friends such as Abdul Latif Bin Abdul Rani, Mohd Armi bin Abu Samah, Mohd Hafiz bin Rosli, Fauzul Azhan and Izudin for their positive critics and wise guidance.

Thank you.

I certify that a Thesis Examination Committee has met on 2 March 2009 to conduct the final examination of Norhakim bin Yusof on his thesis entitled "Lineament Mapping in Malaysian Tropical Forest Environment Utilizing Landsat Imagery" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The committee recommends that the student be awarded the Master of Science.

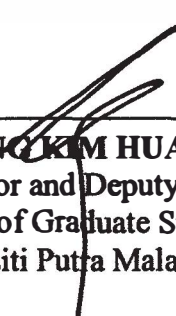
Members of the Thesis Examination Committee were as follows:

Shaharin Ibrahim, PhD
Associate Professor
Faculty of Environmental Studies
Universiti Putra Malaysia
(Chairman)

Shattri Mansor, PhD
Professor
Faculty of Engineering
Universiti Putra Malaysia
(Internal Examiner)

Hj. Kamaruzaman Jusoff, PhD
Professor
Faculty of Forestry
Universiti Putra Malaysia
(Internal Examiner)

Sharifah Mastura Syed Abdullah, PhD
Professor
Faculty of Social Sciences and Humanities
Universiti Kebangsaan Malaysia
(External Examiner)



BUJANG KIM HUAT, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 21 May 2009

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows :

Associate Professor Dr Mohammad Firuz bin Ramli, PhD
Faculty of Environmental Studies
University Putra Malaysia
(Chairman)

Dr Helmi Zulhaidi bin Mohd Shafri
Faculty of Engineering
University Putra Malaysia
(Member)



HASANAH MOHD. GHAZALI, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date : 8 June 2009

DECLARATION

I declare that the thesis is my original work except for quotations and citation which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.



NORHAKIM BIN YUSOF

Date: 23 / 6 / 09

TABLE OF CONTAINS

| | Page |
|---|-------------|
| ABSTRACT | ii |
| ABSTRAK | iv |
| ACKNOWLEDGEMENTS | vi |
| APPROVAL | viii |
| DECLARATION | ix |
| LIST OF TABLES | x |
| LIST OF FIGURES | xiv |
| LIST OF ABBREVIATIONS | xv |
| CHAPTER | |
| 1 INTRODUCTION | |
| 1.1 Introduction | 1 |
| 1.2 Problem Statement and Significance of Study | 5 |
| 1.3 Objectives | 7 |
| CHAPTER | |
| 2 LITERATURE REVIEW | |
| 2.1 Elementary of Remote Sensing | 8 |
| 2.1.1 Space-borne Imaging Sensors | 10 |
| 2.1.2 Satellite Resolution | 15 |
| 2.2 Elements of Image Interpretation | 16 |
| 2.3 Geological Application in Remote Sensing | 18 |
| 2.3.1 Geological Structure utilizing Remote Sensing | 21 |
| 2.3.2 Lineament Features in Remote Sensing | 30 |
| 2.4 Mapping of Lineament using Remote Sensing | 33 |
| 2.4.1 Manual Interpretation Techniques | 34 |
| 2.4.2 Lineament Analysis using Automatic Extraction | 49 |
| 2.5 Summary | 53 |

CHAPTER

3 METHODOLOGY

| | | |
|-------|--|----|
| 3.1 | Flowchart of the Study | 55 |
| 3.2 | Description of the Study Area | 55 |
| 3.3 | Data Type | 59 |
| 3.3.1 | Image Correction | 67 |
| 3.4 | Lineament Identification | 71 |
| 3.5 | Lineament Interpretation using Image Processing Techniques | 74 |
| 3.5.1 | False Color Composite (FCC) | 75 |
| 3.5.2 | Image Fusion | 75 |
| 3.5.3 | Filtering | 76 |
| 3.5.4 | Image Enhancement | 77 |
| 3.5.5 | Digital Elevation Model (DEM) | 78 |
| 3.6 | Lineament Mapping | 80 |
| 3.7 | Fieldwork Measurement | 82 |
| 3.8 | River Mapping | 84 |
| 3.9 | Lineament Map Verification | 86 |
| 3.10 | Summary | 90 |

CHAPTER

4 RESULTS AND DISCUSSIONS

| | | |
|-------|---|-----|
| 4.1 | Final Lineament Extraction | 92 |
| 4.2 | Rose Diagram Analysis for Fieldwork Measurement | 92 |
| 4.3 | Subset of Extracted Lineament and River Segment | 95 |
| 4.4 | Lineament Map Verification | 97 |
| 4.4.1 | Overall Comparison for 10° of Rose Diagram Analysis | 98 |
| 4.4.2 | Overall Comparison for 30° of Rose Diagram Analysis | 116 |
| 4.5 | Comparison of Rose Diagram and Major Lineament from Landsat | 134 |
| 4.6 | Trends Matching | 136 |

| | | |
|-------|---|-----|
| 4.6.1 | Field Measurement and Lineament Trends Matching for Granite Area | 136 |
| 4.6.2 | Field Measurement and Lineament Trends Matching for Metasedimentary Area | 139 |
| 4.7 | Comparison with Geological Map | 146 |
| 4.8 | Discussion | 147 |
| 4.9 | Summary | 158 |

CHAPTER

5 CONCLUSIONS AND RECOMMENDATIONS

| | | |
|-----|-----------------|-----|
| 5.1 | Conclusions | 159 |
| 5.2 | Recommendations | 160 |

| | |
|-------------------|-----|
| REFERENCES | 162 |
|-------------------|-----|

| | |
|---------------------------|-----|
| BIODATA OF STUDENT | 185 |
|---------------------------|-----|

| | |
|-----------------------------|--|
| LIST OF PUBLICATIONS | |
|-----------------------------|--|

LIST OF TABLES

| Table | Page |
|---|-------------|
| 2.1 : Characteristics of the electromagnetic spectrum | 9 |
| 2.2 : Comparison of common satellite imaging systems | 11 |
| 2.3 : Landsat Thematic Mapper (TM) – Landsat 4 and 5 specifications | 14 |
| 2.4 : Satellite resolutions characteristics | 15 |
| 2.5 : Remote sensing interpretation factors characteristics | 17 |
| 2.6 : Geology main applications utilizing the remote sensing technique | 20 |
| 2.7 : Types of discontinuities | 24 |
| 2.8 : Methods of discontinuity survey | 25 |
| 2.9 : List of authors utilizing the scanline method in several applications | 27 |
| 2.10 : Strike and dip definition | 29 |
| 2.11 : Identification of lineament based on authors definition | 31 |
| 2.12 : Types of filter | 43 |
| 2.13 : Sobel kernels in four principal directions | 45 |
| 2.14 : Parameters for the PCI – LINE module for each imagery data | 52 |
| 2.15 : Comparison between the visual and automatic lineament extraction methods | 52 |
| 3.1 : Types of satellite imageries | 60 |
| 3.2 : Types of raster and vector data | 63 |
| 3.3 : Symbol used in this study | 87 |
| 3.4 : Symbol used in this study | 88 |
| 3.5 : Classification for histogram matching | 90 |



| | | | |
|------|---|---|-----|
| 4.1 | : | Classification for histogram matching | 99 |
| 4.2 | : | Comparison of composite lineament orientation between lineament derived from Landsat (LLan which consists of lineament number (LN) and lineament length (LL)) to the field measurement (FM) of granite, metasedimentary rock and for the whole area | 99 |
| 4.3 | : | Comparison of overall lineament orientation derived from Landsat (LLan which consists of lineament number (LN) and lineament length (LL)) and river segment (RS consists of number of river segment (RN) and length of the river segment (RL)) for granite, metasedimentary rock and for the whole area | 101 |
| 4.4 | : | Comparison of lineament orientation between field measurement (FM) and lineament derived from Landsat (LLan which consists of lineament number (LN) and lineament length (LL)) for granite area | 105 |
| 4.5 | : | Comparison of lineament orientation between lineament derived from Landsat (LLan which consists of lineament number (LN) and lineament length (LL)) and river segment (RS consists of number of river segment (RN) and length of the river segment (RL)) for granite area | 106 |
| 4.6a | : | Comparison of lineament orientation derived from field measurement (FM) and lineament derived from Landsat (LLan which consists of lineament number (LN) and lineament length (LL)) in each station in metasedimentary rock area | 109 |
| 4.6b | : | Comparison of lineament orientation derived from rose diagram between field measurement (FM) and lineament derived from Landsat (LLan which consists of lineament number (LN) and lineament length (LL)) in metasedimentary rock area | 113 |
| 4.7 | : | Comparison of lineament orientation from Landsat (LLan which consists of lineament number (LN) and lineament length (LL)) and river segment (RS consists of number of river segment (RN) and length of the river segment (RL)) in each station in metasedimentary rock area | 114 |

| | | | |
|------|---|--|-----|
| 4.8 | : | Comparison of composite lineament orientation between lineament derived from Landsat (LLan which consists of lineament number (LN) and lineament length (LL)) to the field measurement (FM) of granite, metasedimentary rocks and for the whole area | 117 |
| 4.9 | : | Comparison of overall lineament orientation derived from Landsat (LLan which consists of lineament number (LN) and lineament length (LL)) and river segment (RS consists of number of river segment (RN) and length of the river segment (RL)) for granite, metasedimentary rocks and for the whole area | 118 |
| 4.10 | : | Comparison of lineament orientation between field measurement (FM) and lineament derived from Landsat (LLan which consists of lineament number (LN) and lineament length (LL)) for granite area | 121 |
| 4.11 | : | Comparison of lineament orientation between lineament derived from Landsat (LLan which consists of lineament number (LN) and lineament length (LL)) and river segment (RS consists of number of river segment (RN) and length of the river segment (RL)) for granite area | 122 |
| 4.12 | : | Comparison of lineament orientation derived from field measurement (FM) and lineament derived from Landsat (LLan which consists of lineament number (LN) and lineament length (LL)) in each station in metamorphic rock areas | 124 |
| 4.13 | : | Comparison of lineament orientation from Landsat (LLan which consists of lineament number (LN) and lineament length (LL)) and river segment (RS consists of number of river segment (RN) and length of the river segment (RL)) in each station in metasedimentary rock areas | 126 |
| 4.14 | : | Comparison of Lineament Orientation from Landsat TM (Llan) with Field Measurement (FM) for 10° Bin Size | 135 |
| 4.15 | : | Comparison of Lineament Orientation from Landsat TM (Llan) with Field Measurement (FM) for 30° Bin Size | 135 |
| 4.16 | : | Comparison of trends matching between 10° and 30° quadrant of rose diagram in granite area for lineament derived from Landsat (LN and LL) and field measurement (FM) | 137 |

| | | | |
|------|---|--|-----|
| 4.17 | : | Comparison of lineament matching between 10° and 30° quadrant of rose diagram in granite area for lineament derived from Landsat (LN and LL) and River segment (RN and RL) | 138 |
| 4.18 | : | Comparison of lineament matching between 10° and 30° quadrant of rose diagram in metasedimentary area for lineament derived from Landsat (LN and LL) and field measurement (FM) | 139 |
| 4.19 | : | Comparison of lineament matching between 10° and 30° quadrant of rose diagram in metasedimentary area for lineament derived from Landsat (LN and LL) and river segment (RN and RL) | 142 |
| 4.20 | : | Overall total of matching trends between 10° and 30° | 144 |

LIST OF FIGURES

| Figure | Page |
|--|------|
| 3.1 : Research flowchart | 56 |
| 3.2 : Location of the study area on the Landsat ETM+ 2002 with FCC 753 (RGB) | 58 |
| 3.3 : Geometric correction of imagery | 68 |
| 3.4 : Obtaining the GCPs coordinates using the GPS hand held | 69 |
| 3.5a : Location of the valleys on the Landsat ETM+ | 72 |
| 3.5b : Correlation between the river network and valleys on the Landsat ETM+ | 73 |
| 3.6 : Digital Elevation Model of the study area (15° azimuth and sun angle of 10°) | 79 |
| 3.7 : Types of discontinuities found in study area | 83 |
| 3.8a : River network in the study area | 85 |
| 3.8b : River segment from the digitized river network | 86 |
| 4.1 : Final lineament of the study area | 93 |
| 4.2a : Rose diagram generated from 10° quadrant | 94 |
| 4.2b : Rose diagram generated from 30° quadrant | 95 |
| 4.3 : Selected lineaments within 2 km radius from the stations | 96 |
| 4.4 : Selected river segment within 2 km radius | 97 |
| 4.5 : Histogram showing the superimposition technique between Lineament Number (LN) and fieldwork measurement (FM) | 100 |
| 4.6 : Histogram showing the superimposition technique between Lineament Length (LL) and fieldwork measurement (FM) | 100 |
| 4.7 : Location of stations in the study area | 104 |
| 4.8 : Overlay fault on the lineament mapping | 147 |
| 4.9 : 3D perspective of the study area | 155 |

LIST OF ABBREVIATIONS

| | |
|-------------|---------------------------------|
| FCC | False Color Composite |
| PCA | Principle Component Analysis |
| GIS | Geographical Information System |
| TIN | Triangulated Irregular Networks |
| DEM | Digital Elevation Model |
| SI | Superimposition |
| GPS | Global Positioning System |
| TM | Thematic Mapper |
| ETM+ | Enhanced Thematic Mapper Plus |
| GCP | Ground Control Points |
| FM | Field Measurement |
| LN | Number of Lineament |
| LL | Length of Lineament |
| RN | Number of River Segment |
| RL | Length of River Segment |
| LLan | Lineament from Landsat |
| RS | River Segment |

CHAPTER 1

INTRODUCTION

1.1 Introduction

Lineament first defined by Hobbs (1904) as a significant line of landscape which reveals the unseen structure of the rock basement. In geomorphological sense, lineament is defined as a mappable, linear feature of a surface whose parts are aligned in a rectilinear or slightly curvilinear relationship and which differ from the pattern of adjacent features and presumably reflects some sub-surface phenomenon (O'Leary et al., 1976). Gupta (1991) had chosen this definition due to its most practical definition in the perspective of remote sensing image interpretation.

Lineaments are assumed to be evidence of fracturing and may indicate zones of increase porosity, fault traps, drape folds and uplifted blocks in the sense of remote sensing (Prost, 1994). Fractures are commonly caused by stress exceeding the rock strength and cause loss of consistency in rock structure. O'Leary et al. (1976), Davis (1984) and Clark and Wilson (1994) stressed that these structural weaknesses originated mostly around physical discontinuities which reforming of faults, fractures, joint sets and dykes. Structural discontinuities in rocks most often result in linear or curvilinear morphological features along the intersection of fracture plane

and land surface (Masoud and Koike, 2006). For areas especially in hard-rock are generally related with conductive of fracture zones (Hung et al., 2005). Hung et al. (2005) suggested that fractured rocks could be analyzed by revision the lineaments with the help of lineament indices.

Recently, the use of satellite images for geological mapping and exploring resources is becoming increasingly important (Nalbant and Alptekin, 1995). As early as 1974, Rowan (1974) has undertaken the geological studies utilizing the multispectral satellite imagery of ERTS. Gradually the conventional structural geological studies especially in detecting geological lineament utilizing aerial photo is being complemented, and replaced with the multispectral airborne or satellite imagery (Siegel and Abrams, 1976; Drury, 1986; Smithurst et al., 1987; Juhari and Ibrahim, 1997; Arlegui and Soriano, 1998; Kumanan, 2001; Madani, 2001; Hung et al., 2005; Ricchetti and Palombella, 2005). Boyer and McQueen (1964) found that the lineament may be emphasized by the vegetation and topography in the imagery inform of linear features which has successfully evidenced the reflection of rock fractures.

The conventional geological mapping of structures like faults, folds and lineaments for structural analysis have provided useful information on structure and stress distribution in small area (Bucher, 1920, Friedman, 1961). Basically, the conventional lineament extraction techniques were regularly based on the visual interpretation on the aerial photographs or paper-based satellite image mosaics

(Masoud and Koike, 2006). This technique was performed utilizing the hand tracing on the overlaid transparent paper by delineating the interpreted lineaments on the aerial photo or the mosaics imageries. However, for regional mapping projects, these techniques are time-consuming, tedious, subjective, and irreproducible (Masoud and Koike, 2006).

Satellite images are among continuous sources of data for mapping lineaments which normally reflect to surfaces of discontinuity in the rock (Mostafa and Bishta, 2005). Thus, the advantages of wide ground coverage and the relative high resolution with respect to scale presented by the satellite images enables regional and local lineament analysis to be analyses in a more accurate way (Suzen and Toprak, 1998). The imagery also may be improved through the image enhancement techniques, where the feature sharpness and contrast increase the effectiveness of the interpretation process in geological applications (Basappa and Gaikwad, 1985; Krishnamurthy, 1997). The geological mapping prepared from the imagery is more cost effective and this mapping may be better rather than utilizing ground observations alone (Krishnamurthy, 1997; Gupta, 2003; Saraf et al., 2004). Therefore, the lack of detecting the continuity of topographic features related to geological structure in field mapping (Drury, 1986) may be compliment with the satellite imagery. Nevertheless, the remote sensing interpretation data must be supported by field measurement data which may be accurately localized and characterized the study area (Gupta, 2003, Peña and Abdelsalam, 2006). Besides, visual interpretation from imagery data is also subsequently compared with results of surface geological mapping (Peña and Abdelsalam, 2006) to verify the geological interpretation accuracy.

The main purpose in this study is to demonstrate the use of multispectral Landsat TM and ETM+ satellite data obtained at different two acquisition dates in year 1990 and 2002 for the lineament interpretation in a Malaysian tropical environment. The high spectral resolution of multispectral Landsat along with image improvement techniques were utilized in this study. The visual interpretation was the main task for identifying the lineaments on the imagery, thus the identified lineaments were delineated manually on the screen. The subjectivity factor which been a crucial issues in lineament identification was also undertaken to enhance the accuracy of extracted lineaments. The obtained final lineament map was than confirmed with the ground verification by comparing with the field measurements and river segments. The verifications were carried out to validate the accuracy of the extracted lineaments and to confirm the influence of river segment to the existing lineaments.

1.2 Problem Statement and Significance of Study

Most of the geological studies in remote sensing applications are more on to the understanding the geological structural interpretation (Arlegui and Soriano, 1998; Pradeep et al., 2000; Hung and Batelaan, 2003; Syed and Saied, 2004; Akman and Tüfekçi, 2004; Mostafa and Bishta, 2004; Richetti and Palombella, 2005; Morelli and Piana, 2006; Yassaghi, 2006). However, only Arlegui and Soriano (1998) discussed the relationship between faults from the outcrop scale to the lineaments on the map. None of these studies undertake any detail comparison of joint and foliation trends from field mapping to the lineament trends detected on the Landsat or any satellite imagery.

Besides, other issue that arises in the lineament mapping procedure is the subjectivity factor (Gupta, 1991; Mabee et al., 1994). This is involved in the identification of the lineament in satellite imagery. From the literature, there was no specific and seldom employed measurement undertaken to minimize the subjectivity factor in lineament extraction (Mabee et al., 1994).

In addition, referring to the fault map obtained from the Mineral and Geoscience Department (JMG) only four major fault lines were discovered in the study area. The fault map was produced manually from the mosaic aerial photos. However, utilizing with better resolutions of spatial and spectral obtained from the satellite imagery such as the Landsat imagery probably may resolve more lineaments in terms of

number and length. It is also important to point out herein that the study area is mostly been covered by the thick tropical forest. This also gives a problem to the geologist to identify and verify the fresh outcrop by occupying the geological survey in the field. The survey work is more preferred in providing information on structure distribution in small area. However, for regional mapping projects, this technique is time-consuming, tedious, subjective, and irreproducible (Masoud and Koike, 2006). Thus, it shows that the needs of new improved techniques to enhance the quality and accuracy of the lineaments interpretation especially in the area that mostly covered by tropical forest environment.

This study was undertaken for identifying the lineaments in the thick forest area where the geological features located beneath the vegetation cover which are very difficult to be seen in the satellite imagery. The final lineaments with minimum subjectivity factor were compared with the outcrop field mapping comprise of foliation and joint measurements of the study area. This verification was used to verify the accuracy of the extracted lineaments from the Landsat imagery. Thus, the undertaken study will assist and improve the techniques to identify more lineaments which may cater any inadequate lineaments features from the previous method.